Research on the Impact of Heterogeneous Environmental Regulation on Enterprise Green Technology Innovation—Research on the Mediating Effect of Organizational Green Learning

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Abstract: *Based on the logical relationship between heterogeneous environmental regulation, organizational green learning and enterprise green innovation, this paper empirically tests the impact of environmental regulation on enterprise green innovation through questionnaire design and receipt survey, and discusses the mediating role of organizational green learning between heterogeneous environmental regulation and enterprise green innovation. The research conclusion shows that command-and-control environmental regulation, Market-incentivized environmental regulation and voluntary participatory environmental regulation have a positive impact on organizational green learning and enterprise green technology innovation, and voluntary participatory environmental regulation has the greatest impact on organizational green learning and enterprise green technology innovation, and organizing green learning plays an intermediary role between environmental regulation and enterprise green innovation. Therefore, the formulation of relevant national environmental regulation policies should fully mobilize the enthusiasm of enterprises to voluntarily participate in environmental regulation and effectively promote the green innovation ability of enterprises.*

Keywords: *Environmental Regulation; Green Innovation; Green Learning; Mediation effect; Heterogeneity*

1. Introduction

The digital economy emphasizes ecological standards, takes ecology as the trend and principle, incorporates factors such as resource consumption, environmental damage, and ecological benefits into the digital economy, considers the impact of the digital economy on technological innovation, and analyzes the inflection point of reducing the intensity of environmental regulation. The concept of green development believes that China's high-quality economic development will no longer rely on factors to drive, but on green technology innovation, and China's 14th Five-Year Plan and 2035 long-term development goals, digital economy, environmental regulation, green innovation, and other factors affecting green development have been frequently mentioned many times. At present, there are four main views on environmental regulation and technological innovation: one is that the cost of environmental regulation can be offset by the compensation effect of enterprise innovation, and environmental regulation is conducive to technological innovation; Second, it is believed that in the case of limited enterprise resources, corporate environmental regulation will increase enterprise investment, which will inhibit enterprise innovation; Third, there is a U-shaped relationship between environmental regulation and innovation, in the short term, the investment in environmental pollution control of enterprises will crowd out the green innovation investment of enterprises, and the long-term innovation compensation effect will generate additional profits after compensating for innovation investment, and then help enterprises to carry out a new round of green technology innovation; Fourth, there is no obvious relationship between environmental regulation and green technology innovation. For example, Yuan (2015) analyzed data on environmental regulation and green technology innovation for manufacturing industry in China from 2003 to 2014 and found that environmental regulation did not improve eco-efficiency or enhance the technological innovation capacity of manufacturing enterprises. It can be seen that relevant research on environmental regulation and enterprise green innovation is still in its infancy,

environmental regulation can be divided into command, market and autonomous, etc., different types of environmental regulation on the impact of enterprise green innovation ability is bound to be different, when enterprises bear different environmental regulation pressure, it is bound to innovate by transforming existing processes and through organizational learning.

In relevant research at home and abroad, it is found that organizational learning has an obvious driving effect on the formation and development of enterprise innovation ability, in addition, organizational learning is also divided into exploratory and developmental organizational learning forms, large enterprises have strong ability to dominate resources, can effectively take into account exploratory and developmental learning forms, while small and medium-sized enterprises often only prefer development-based learning forms, some studies have found that the complementary effects of the two forms of learning are significant, and there is an intermediary role between enterprise green innovation and enterprise performance. Improving the innovation ability of the organization through organizational learning is an important factor in improving the green performance of the organization. Disruptive innovation theory states that companies will be most likely when they face long-term and short-term coordination dilemmas and cannot switch to new business models. Businesses will eventually die. Disruptive innovation is often constrained by silent costs and high expected profits, and incumbents tend to have less incentive to innovate than newcomers. Innovation is often accompanied by subversion of existing knowledge, organizational ability is an important factor driving enterprise innovation, and organizations form knowledge creation through internal process transformation or through inter-organizational exploratory and utilitarian learning [1], exploratory learning focuses on the breadth of knowledge search, and utilitarian learning focuses on the depth of knowledge search. Pan Songting and Zheng Yali (2011) studied the relationship between organizational learning and corporate breakthrough innovation and incremental innovation, and believed that organizational learning plays a mediating role in the relationship between network relationship strength and enterprise technological innovation [2]. The form of organizational learning in enterprises will mostly undergo a transformation from exploratory activities to utilization activities, and there is a transition from never balanced to balanced [3], and compared with exploratory learning, organizational utilization learning has a stronger impact on green innovation [4]. Then, in the case of environmental regulation, what is the impact of exploratory and utilitative organizational green learning on the green technology innovation of enterprises, positive or negative, and it is worth exploring in depth through exploratory organizational learning and utilitarian organizational learning. Therefore, the focus of this study is as follows: First, what is the difference between the impact of exploratory learning on corporate green technology innovation and the impact of utilization mode learning? Second, in the case of defining organizational green learning as a mediating variable, the study of the extent of heterogeneous environmental regulation on the green innovation ability of enterprises. To this end, the relevant theories were sorted out, and on the basis of research and interviews with 200 enterprise workers in the Guangdong-Hong Kong-Macao Greater Bay Area, relevant data were obtained and hypothesis tests were conducted.

2. Theoretical basis and research hypothesis

2.1 Environmental regulation and organizing green learning

Organizational green learning pays more attention to the implementation of green concepts, and unlike general organizational learning, organizational green learning is usually generated by enterprises under external pressure or incentives. When external factors such as imperative environmental regulation, market incentive environmental regulation and voluntary participatory environmental regulation form certain constraints on enterprises, enterprises will inevitably carry out green innovation through organizing green learning to avoid being constrained by external forces. Some scholars believe that organizational green learning is an inevitable strategic choice for enterprises to cope with changes in external factors, and when the organization is under the pressure of external public opinion, it will inevitably achieve organizational green innovation through organizational green learning to avoid the influence of external factors. Therefore, different types of environmental regulations will put pressure on enterprises, and enterprises can respond to the pressure by organizing green learning to achieve the green performance of enterprises. Based on this, the hypothesis proposed by the text is as follows:

H1: Heterogeneous environmental regulation can effectively promote green learning in enterprises.

2.2 Environmental regulation and corporate green innovation

Adopting environmental regulatory measures to reduce the pressure on the environment can promote green innovation in the environment. Some scholars believe that organizational legitimacy plays a mediating role between environmental regulation and corporate green innovation, and when the government's environmental regulation policies continue to be implemented and continuously improved, environmental regulation plays a significant role in promoting corporate green innovation [5]. The government guides enterprises to transform from polluting enterprises to clean enterprises through environmental regulation, and uses innovative ideas and new technologies to reduce resource consumption and environmental pollution, so as to achieve industrial transformation and upgrading [6]. Based on this, the hypotheses proposed in this paper are as follows:

H2: Heterogeneous environmental regulation can positively affect the innovation of green technology of enterprises.

2.3 Organize green learning and enterprise green innovation

In the process of the formation and development of enterprise innovation capabilities, organizational learning has unleashed an increasingly obvious driving role [7]. In the case of the dual learning capabilities of development learning and exploratory learning in enterprises, development learning and exploratory learning in organizational activities can effectively promote the R&D and assembly capabilities of enterprises [8]. By updating the original thinking and viewpoints of the enterprise, the enterprise can quickly grasp the cutting-edge theories and knowledge through green learning, which can improve the efficiency of the enterprise's green innovation. Li et al. believe that the utilization and exploratory learning of environmental knowledge can effectively promote the green technology innovation of enterprises and have a positive impact on the environmental performance of enterprises [9]. Cui Rixiao et al.(2019) believe that the more knowledge an enterprise acquires from other external organizations, the more it can help the organization get rid of the shackles of inertial thinking, which is conducive to the acquisition of innovation resources and the implementation of green management innovation[9]. In addition, based on this, the following hypotheses are proposed:

H3: Organizing green learning has a positive impact on corporate green innovation.

2.4 The green intermediary role of organizing green learning

Environmental regulation is the organization of green learning indirectly affects the green innovation of enterprises, and actively carries out green learning in the face of external environmental regulations to promote the company's green innovation. Dai Wanliang and Lu Wenling (2020) believe that there are two ways to organize green learning from industry green leaders and strengthen internal integration: the former focuses on learning from the outside and introducing new green innovative technologies; The latter emphasizes the generation of green ideas within the enterprises [13]. Under the pressure of environmental regulations, the organization of green learning helps enterprises to continuously integrate internal and external resources to carry out enterprise innovation, and form green knowledge in green innovation concepts to guide enterprises' green innovation behaviors. The role of organizing green learning in corporate green innovation cannot be underestimated. Based on this, the following hypotheses are proposed:

H4: Organizing green learning is a bridge between environmental regulation and corporate green innovation.

Figure 1 illustrates the relationship between heterogeneous environmental regulation, organizational green learning, and corporate green innovation.
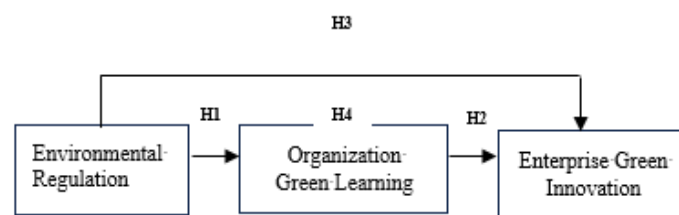

Figure 1: Theoretical model

3. Data collection and research methods

3.1 Questionnaire Design and Data Collection

From the perspective of industrial development layout, the Guangdong-Hong Kong-Macao Greater Bay Area has basically formed a new pattern of industrial development of "one core, one belt and one zone", and the new industrial ecology requires enterprises to develop green industries under the condition of ensuring ecological security. To this end, Guangdong has successively issued a series of ecological environmental protection and related laws and local regulations on ecological environmental protection, such as the Regulations of Guangdong Province on Environmental Protection, the Trial Measures for the Management of Carbon Emissions in Guangdong Province, and the 14th Five-Year Plan for Ecological Environmental Protection of Guangdong Province, forcing enterprises to carry out green innovation. Therefore, this paper takes enterprises in the Guangdong-Hong Kong-Macao Greater Bay Area as the main research object, studies the relationship between heterogeneous environmental regulation, organized green learning and green innovation, and provides certain ideas for the green development of enterprises in the Guangdong-Hong Kong-Macao Greater Bay Area. Referring to the questionnaire formed by relevant research and scales at home and abroad, and improving and measuring the scale through expert interviews to form the final questionnaire, the questionnaire uses the Likrt 5-point scale method to investigate the questions, and 1-5 respectively indicate that they are divided into "strongly disagree" to "strongly agree" according to the degree of satisfaction.

The survey subjects in this article are mainly enterprises in the Guangdong-Hong Kong-Macao Greater Bay Area, and the data is collected from February 2023 to March 2023. 360 questionnaires were distributed, and 321 valid questionnaires were obtained through online and offline surveys and screening, with an effective recovery rate of 89.72%. Table 1 lists the detail description of the sample. From the descriptive statistics of the data, 59.19% of the enterprises in the data are medium-sized enterprises, and the proportion of R&D departments accounts for 62.93%, and the enterprises established for more than 10 years account for 47.35%.

Table 1: Sample statistics

	Samples	**Qty**	**Weight**
Size of Enterprise	Small Business	83	25.86%
	Medium-sized Businesses	190	59.19%
	Big Business	48	14.95%
Department	R&D department	202	62.93%
	Other department	119	37.07%
Years of Establishment	<5 years	32	9.97%
	6-10 Years	137	42.68%
	>10 Years	152	47.35%

3.2 Variable Measurement

3.2.1 Environmental regulation (ER)

The measurement of heterogeneous environmental regulation was measured from 12 items in three dimensions: command-and-control environmental regulation (CER), market incentive environmental regulation (MER), and voluntary participatory environmental regulation (VER), with reference to the scale used by Wang Shuying et al. [10], Yang Yanfang and Cheng Xiang [11], Cao Hongjun and Sun Jihui [12]. The market-incentive environmental regulation includes four items: "enterprise environmental protection projects can enjoy government subsidies and support", "enterprises must bear the corresponding taxes and fees for pollutant discharge", and "enterprises will be punished for pollutant discharge if they discharge pollutants for excessive leakage". The voluntary participatory environmental regulation includes four items: "enterprises can release environmental information in a timely and accurate manner on public platforms", "enterprises have implemented cleaner production and whole-process control processes", and "enterprises have made active and voluntary commitments to meet the requirements of environmental protection regulations".

3.2.2 Organization Green Learning (GL)

Drawing on the scales used by Dai Wanliang, Lu Wenling [13], Cao Hongjun and Sun Jihui [14], the measures were carried out from two dimensions: utilitarian green learning (UGL) and exploratory green

learning (EGL), which included four items: "we will learn the existing green environmental protection knowledge", "we will consider the existing knowledge to make green improvements to the production components", "we will apply the new green environmental protection knowledge to existing projects", and "we make the existing process more environmentally friendly through environmental protection knowledge learning". Exploratory green learning includes four items: "We want to master more advanced green environmental protection information", "We will learn more green environmental protection knowledge by collecting information", "We will learn new environmental protection knowledge and develop new green projects", and "We introduce new knowledge to carry out breakthrough green technology innovation".

3.2.3 Corporate Green Innovation (GI)

Drawing on the research methods of Li Jieyi et al. [9], Yang Yanfang and Cheng Xiang [11], the measurement of corporate green innovation is changed from "enterprises will actively research and develop new green products", "enterprises use less polluting raw materials in product design", "enterprises reduce the waste of raw materials through technological improvement in product production", "enterprises consider the recyclability of products in product design", "enterprises will choose product solutions to reduce energy consumption", and "enterprises will recycle the waste of recycled products" 6 items for research.

3.2.4 Control variables

Cao Hongjun and Sun Jihui [14] believe that enterprise size and establishment years will significantly affect enterprise green innovation. Therefore, the size and years of establishment of enterprises are added to the research as control variables, which have become important variables affecting environmental regulation and corporate green innovation.

4. Empirical research

Exploratory factor analysis was performed on 26 measurement items, and the KMO value in the results was 0.919, and the significance of the Bartlett test was less than 0.000, In order to further test the reliability and validity, the results of the reliability and validity test are shown in Table 2. (1) The reliability coefficient value of each variable is between 0.56-0.67, and the combined reliability CR value is greater than 0.74, indicating that the reliability of the scale is good; (2) The factor load of each item is between 0.6-0.9, and the AVE value is about 0.5, indicating that the convergence degree of the scale is good. In summary, the reliability and validity of the scale are good, and empirical tests can be carried out.

4.1 Reliability and validity analysis

Table 2: Reliability and validity test of variables

Var.	Measure Items	Factor loading	α
Command-Controlled Environmental Regulation (CER)	Environmental laws and regulations have relatively complete environmental constraints on enterprises	0.608	0.621
CR=0.778 AVE=0.545	The environmental policy system has relatively complete environmental constraints on enterprises	0.685	
	The company has a special environmental supervision department	0.893	
Market-Incentive Environmental Regulation (MER) CR=0.744 AVE=0.428	Enterprises enjoy the green tax of "more emissions and more payments, less emissions and less payments, and no emissions and no payments".	0.682	0.574
	Enterprise environmental protection projects can enjoy government subsidies and support	0.802	
	Enterprises shall bear the corresponding taxes and fees for pollutant discharge	0.524	
	Enterprises that discharge pollutants for more than one leakage will be punished for pollutant discharge	0.573	

Voluntary-Participatory Environmental Regulation (VER) CR=0.775 AVE=0.464	The company has passed the ISO14001 environmental management system certification	0.661	0.623
	Enterprises can release environmental information on public platforms in a timely and accurate manner	0.761	
	Cleaner production and whole process control processes have been implemented	0.613	
	Companies have made a commitment to proactively and voluntarily meet environmental regulatory requirements	0.680	
Utilized Green Learning (UGL) CR=0.750 AVE=0.429	We will learn from existing green environmental protection knowledge	0.596	0.556
	We consider making green improvements to our production components based on our existing knowledge	0.654	
	We apply new green knowledge to existing projects	0.670	
	We learn from environmental knowledge to make existing processes more environmentally friendly	0.695	
Exploratory Green Learning (EGL) CR=0.784 AVE=0.547	We will learn more about green environmental protection by collecting information	0.720	0.586
	We will learn new environmental knowledge and develop new green projects	0.765	
	We bring in new knowledge for breakthrough green technology innovation	0.734	
Enterprise green innovation CR=0.783 AVE=0.377	Enterprises will actively research and develop new green products	0.642	0.670
	Companies use less polluting raw materials in product design	0.627	
	Enterprises reduce the waste of raw materials through technological improvement in the production of products	0.584	
	Companies consider the recyclability of products when designing their products	0.621	
	Companies will opt for products that reduce energy consumption	0.551	
	The company recycles the waste from recycled products	0.652	

4.2 Descriptive statistics of variables

Table 3 shows the descriptive statistics of each variable set for the study, and the relationship between each variable is preliminarily analyzed by describing the correlation coefficient of each variable. There is a significant correlation between different types of environmental regulation and different organizational learning styles and enterprises' green innovation.

Table 3: Descriptive statistics of variables

Var	Average	Standard Deviation	YR	ES	CER	MER	VER	UGL	EGL	GI
YR	2.364	0.660	1							
ES	1.899	0.629	0.303**	1						
CER	3.979	0.649	0.065	0.199**	1					
MER	4.11	0.557	0.057	0.143*	0.584**	1				
VER	4.031	0.585	0.08	0.129*	0.685**	0.541**	1			
UGL	4.133	0.525	0.025	0.019	0.557**	0.561**	0.631**	1		
EGL	4.084	0.631	-0.005	-0.013	0.535**	0.434**	0.531**	0.641**	1	
GI	4.073	0.522	-0.011	0.042	0.610**	0.513**	0.692**	0.731**	0.672**	1

Mark: *means $p<0.05$;**means $p<0.01$

As shown in Table 3, command-and-control environmental regulation was positively correlated with market-incentivized environmental regulation ($r=0.584$; $p<0.01$), voluntary participatory environmental regulation ($r=0.685$; $p<0.01$), utilised green learning ($r=0.557$; $p<0.01$), exploratory green learning ($r=0.535$; $p<0.01$), and enterprise green innovation ($r=0.610$; $p<0.01$). Market-incentivized environmental regulation was positively correlated with voluntary participatory environmental regulation ($r=0.541$; $p<0.01$), utilised green learning ($r=0.561$; $p<0.01$), exploratory green learning

(r=0.434; p<0.01), and enterprise green innovation (r=0.513; p<0.01). Voluntary participatory environmental regulation was positively correlated with utilised green learning (r=0.631; p<0.01), exploratory green learning (r=0.531; p<0.01), and corporate green innovation (r=0.692; p<0.01). In addition, utilised green learning was positively correlated with exploratory green learning (r=0.641; p<0.01) and enterprise green innovation (r=0.731; p<0.01). Finally, exploratory green learning was significantly positively correlated with enterprise green innovation (r=0.672; p<0.01). In addition, firm size was positively correlated with command-and-control environmental regulation (r=0.199; p<0.01), market-incentivized environmental regulation (r=0.143; p<0.05) and voluntary participatory environmental regulation (r=0.129; p<0.05).

4.3 Regression analysis

In this paper, hierarchical regression analysis is used to verify the relationship between heterogeneous environmental regulation, organizational green learning and corporate green innovation, and the regression results are shown in Table 4.

The relationship between heterogeneous environmental regulation and organizational green learning is shown in models (1)-(4). From the perspective of models (1) and (3), the establishment period and enterprise size have no effect on utilization learning and exploratory learning, and after adding the influence of different environmental regulations in models (2) and (4), the results show that command-and-control environmental regulation, market-incentive environmental regulation, voluntary participatory environmental regulation and utilization learning are positively significant at the 1% level, with significant coefficients of 0.143, 0.277 and 0.396, respectively, which are positively significant at the 1% level with exploratory learning. The significant coefficients were 0.296, 0.131 and 0.274, respectively, indicating that heterogeneous environmental regulation can effectively promote green learning in enterprises. In terms of the degree of impact, the promotion effect of voluntary participatory environmental regulation on enterprise utilization learning is significantly higher than that of market incentive environmental regulation and command-and-control environmental regulation. The reason for this is that, under voluntary participatory environmental regulation, organizations may be more willing to share environmental information and experience with each other to improve the environmental protection level. This information sharing helps organizations understand and learn from other organizations' green practices, thereby improving their own green learning capabilities. In the market competition, enterprises must continue to improve their environmental protection level to achieve a competitive advantage. In addition, as consumers, investors, and policymakers become more concerned about environmental protection, organizations need to embrace corporate social responsibility and adopt green measures. Voluntary participatory environmental regulation provides a platform for organizations to showcase their environmental achievements, which can help stimulate competitive pressure among organizations to enhance green learning.

Enterprise utilization learning is mainly the use of existing environmental knowledge and components to update the enterprise project and process, the cost of green innovation is relatively small, the voluntary environmental regulation behavior can stimulate the enterprise to develop new skills to carry out environmental protection, although the market incentive and command control can also stimulate the enterprise to update the existing process and technology, but through the external administrative system and laws and regulations to punish or reward the green environmental protection behavior of the enterprise, its promotion effect is less than the voluntary environmental regulation behavior. It's different from the learning mode of transforming existing technical skills, enterprise exploratory learning pays more attention to the development and research of new knowledge and new skills, and the research and development of new technologies often consumes more time and energy by learning new green environmental protection knowledge.

In order to further investigate, the relationship between heterogeneous environmental regulation, organizational green learning and corporate green innovation is shown in the model (5)-(8), which shows that there is no significant relationship between establishment years, enterprise size and corporate green innovation, and the regression results of heterogeneous environmental regulation on corporate green innovation are significant without considering organizational green learning, and the impact coefficients of command-and-control environmental regulation, market-incentive environmental regulation and voluntary participatory environmental regulation on corporate green innovation are 0.216, respectively 0.139 and 0.481, voluntary participatory environmental regulation has a greater impact on corporate green innovation than the other two environmental regulations. This means that when enterprises voluntarily release environmental information, voluntarily carry out cleaner production and environmental quality system certification, and actively fulfill environmental protection regulatory

requirements, enterprises are more motivated to carry out green technology innovation.

From the regression results of table 4, the impact of voluntary participatory environmental regulation and command-and-control environmental regulation on corporate green innovation is significant at the level of 1% and 10% respectively, and utilitarian learning and exploratory learning are significantly positively correlated with corporate green innovation, which indicates that under the role of heterogeneous environmental regulation, corporate green learning ability can effectively promote corporate green innovation. Moreover, the impact of exploitative learning on enterprise innovation is significantly higher than that of exploratory learning.

Table 4: Regression results

	Utilised Learning		Exploratory Learning		Enterprise Green Innovation			
Var	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	4.073***	1.324***	4.112***	1.405***	4.043***	1.317***	0.804***	0.581***
	(32.402)	(7.031)	(27.211)	(5.590)	(32.385)	(7.403)	(4.781)	(3.561)
YR	0.021	-0.002	-0.002	-0.017	-0.026	-0.051	-0.036	-0.046
	(0.354)	(0.039)	(0.026)	(0.363)	(0.442)	(1.248)	(0.974)	(1.340)
ES	0.013	-0.100***	-0.013	-0.121	0.050	-0.068	0.048	-0.004
	(0.217)	(2.281)	(0.212)	(2.495)	(0.840)	(1.636)	(1.275)	(0.108)
CER		0.143***		0.296***		0.216***		0.093*
		(2.374)		(4.420)		(3.767)		(1.867)
MER		0.277***		0.131***		0.139***		0.013
		(5.351)		(2.272)		(2.817)		(0.291)
VER		0.396***		0.274***		0.481***		0.279***
		(6.852)		(4.274)		(8.770)		(5.614)
UGR							0.510***	0.335***
							(11.005)	(6.751)
EGR							0.346***	0.253***
							(7.465)	(5.670)
F	0.120	57.985	0.027	35.290	0.02	70.957	0.04	90.197
R2	0.001	0.475	0.001	0.352	0.002	0.526	0.603	0.665

Mark: *means $p<0.1$, **means $p<0.05$, *** means $p<0.01$

Therefore, under the influence of heterogeneous environmental regulation, organizational utilization learning and exploratory learning can effectively promote corporate green innovation, while organizational green learning plays a mediating role between environmental regulation and corporate innovation, and voluntary participatory environmental regulation has the most significant impact on corporate green innovation. The reason for this is that under strict environmental regulations, organizations voluntarily adopt more green measures to reduce environmental costs and risks. To achieve this, organizations must continuously learn and master scientific knowledge, skills, and experience. This green learning process helps organizations to be more innovative. Organizing green learning can increase employees' awareness and attention to environmental issues, which in turn stimulates their enthusiasm for innovation. By learning from other organizations' green practices and successful experiences, organizations can find more suitable environmental solutions, reduce environmental protection costs, and improve competitiveness. Therefore, organizing green learning can realize the positive interaction between voluntary participatory environmental regulation and enterprise innovation.

5. Conclusions and implications

Based on the survey data of enterprises, this paper empirically tests the impact of environmental regulation on corporate green innovation with organizational green learning as the mediator. The results show that: (1) Heterogeneous environmental regulation has a positive impact on organizational green learning behavior, and voluntary participatory environmental regulation has a greater impact on organizational utilization green learning, and command-and-control environmental regulation has a greater impact on organizational exploratory green learning. (2) There is a significant positive correlation between exploratory learning and corporate green innovation, and under the effect of heterogeneous environmental regulation, corporate green learning ability can effectively promote corporate green innovation, and the impact of exploratory learning on corporate innovation is significantly higher than that of exploratory learning. (3) Organize green learning to effectively connect environmental regulation and corporate green innovation. Organizational learning is an effective way to promote enterprise

innovation, under the introduction of different national environmental regulatory policies, enterprises can effectively improve the level of green innovation through the transformation of existing processes, and by learning from the same industry, the company can establish a long-term mechanism for environmental regulation to promote green learning of organizations, and then promote green innovation of enterprises. (4) Under normal circumstances, the larger the scale of the enterprise, the longer the operation time, with the accumulation of business results, the more motivated the business results to invest in research and development to improve the innovation level of the enterprise. However, the empirical results of this paper do not support this hypothesis, and the reason may be that more and more companies are aware of the importance of green innovation to the survival of enterprises, and even small enterprises that have been established for a short time are increasing their investment in green innovation.

Based on the above conclusions, the implications for us are as follows: (1) Heterogeneous environmental regulation can effectively promote corporate green learning and corporate green innovation, and the state should effectively combine different environmental regulation policies when formulating relevant policies to achieve a balance between environmental protection and economic development. This requires the government to fully consider the characteristics and needs of various industries in the process of policy formulation and implementation, pay attention to communication and cooperation with enterprises, and take flexible and targeted measures. Pay attention to the proportion and intensity of different environmental regulatory policies, and formulate policies and regulations that can most effectively promote green innovation of enterprises; (2) Through voluntary participatory environmental regulation, corporate green innovation can be more promoted. In the formulation of policies and regulations, the voluntary conduct of environmental regulation should be regarded as an important guide for the formulation of national environmental regulation policies, and the state should increase the publicity of environmental protection policies, improve the enthusiasm of enterprises to voluntarily participate in environmental regulations, and guide enterprises to consciously fulfill their environmental protection responsibilities and promote green development. Through the establishment and improvement of incentive mechanisms, enterprises are encouraged to adopt environmental protection technologies and cleaner production methods, reduce pollution emissions, and achieve green development; (3) Voluntary participation in environmental regulation can effectively promote enterprises to carry out green learning, which means that enterprises have a higher understanding and attention to environmental protection, which helps to stimulate the enthusiasm of enterprises to carry out green learning. Enterprises will take the initiative to learn environmental knowledge, skills and experience to improve their environmental performance. Enterprises should combine their own development situation, reasonably choose exploratory or utilitarian learning methods, reflect environmental regulation behaviors in the production process of enterprises, strengthen the cultivation of relevant environmental regulation talents of enterprises, and improve the green innovation ability of enterprises.

Acknowledgements

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